ecosystem
MANAGEMENT AND RESTORATION

Technology News from the Ecosystem Management and Restoration Research Program September 1998

Ecosystem Management and Restoration Research Program—providing technology for Corps leadership in ecosystem management

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The Ecosystem Management and Restoration Research Program (EMRRP) was initiated in 1997 as part of the U.S. Army Corps of Engineers' response to a national shift in environmental research and development.

The program provides state-of-the-science methods and procedures to predict and analyze environmental impacts of Corps projects and activities with application toward ecosystem management and restoration.

EMRRP research is developing both short- and long-range solutions to problems in several Corps mission areas (the Environment, Navigation, Recreation, Regulatory, Support for Others, and Water Supply), and addresses the requirements of more than 20 Legislative Acts, including the National Environmental Policy Act.

The program's stand-alone yet interrelated work units focus on research technology areas designed to develop capabilities to predict ecosystem impacts, develop ecosystem management and decision support systems, develop rapid quantification and assessment methods, investigate basic ecosystem processes, and restore habitat for species of concern to Corps natural resource managers.

In the past few years, more and more emphasis has been placed on managing and restoring the environment at the ecosystem level. Several major projects have been initiated, including the Florida Everglades, the Yolo Basin in California, and the Yellowstone area in Montana.

A new Congressional initiative sponsored by Senator Christopher "Kit" Bond (Missouri) would "enhance, preserve, and protect habitat for fish and wildlife on the Mississippi and Missouri Rivers at a cost of $50 million over 5 years.

At the Yolo Basin Wildlife Preserve Dedication on November 15, 1997, President Clinton, in referencing this new emphasis on large, nationally important restoration projects, said, "I've seen a glimpse of America's future, and I like it."

Leadership in the Corps likes it also, and they see a major role for the Corps in bringing its engineering and environmental expertise to bear on the problem.

As a result of, and in response to this new emphasis, the Corps of Engineers initiated the Ecosystem Management and Restoration Research Program in 1997 with General

Investigation funding. The EMRRP developed directly from the Environmental Impact Research Program, a previous Corps research program that has been discontinued.

The EMRRP program management and research are coordinated at the U.S. Army Engineer Waterways Experiment Station.

EMRRP research is for application at the "ecosystem" level, which by Corps regulation is defined as "the dynamic and interrelating complex of plant and animal communities and their associated non-living environment."

Such research is dynamic and national in scope and has been focused to address national goals and priorities, emphasizing improved project operation and maintenance and rehabilitation rather than new construction.

This strategy demands innovative techniques that can be implemented with reduced resources.

Program technical issues and technology areas

The technical issues that the EMRRP addresses were developed from Corps field needs and requirements, which can be grouped into three categories: (1) analytical tools for determining the ecosystem restoration/management requirements of Corps projects and activities, (2) development, refinement, and field demonstration of technologies for restoration and management of ecosystems, and (3) investigation of basic ecosystem processes to support the development of innovative analytical tools and restoration/management technologies.

These technical issues follow a well-defined logic that, in step-wise manner, determines "what's broken or in need of repair" (Category 1); "if it's broken, then how do we fix it" (Category 2); and lastly, "how can we, or do we, prevent breakage in the first place" (Category 3).

This logical approach is the unifying thread of all program elements and provides an important focus for such a broad research area.

Considering both the technical issues that emerged from Corps field requirements and the complex, rapidly developing, interdisciplinary nature of the ecosystem sciences, there was a need to further focus the EMRRP into specific but interrelated technology development and refinement areas.

These technology areas direct EMRRP research efforts toward (1) developing capabilities to predict ecosystem impacts, (2) developing ecosystem management and decision support systems, (3) developing rapid quantification and assessment methods, (4) investigating basic ecosystem processes, and (5) restoring habitat for species of concern.

EMRRP work units

✦ Restoration and enhancement of aquatic habitats

A comprehensive list of restoration techniques used in Corps projects is being compiled, and the economic and engineering requirements for each technique are being evaluated.

Commonly used techniques—placement of instream structure, substrate manipulation, and management of hydrological regime—are being field tested at selected sites to determine

the composition of fish and macroinvertebrate assemblages associated with each technique.

In addition, the functional value of the techniques for spawning, rearing, and foraging of fish is being measured.

Environmental benefits derived from restoration techniques will be quantified, and recommendations on engineering design and placement will be developed.

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✦ Effects of reservoir operations on habitats of target species

This effort will be accomplished as four tasks. The first task is to assess the scope of the problem, that is, to identify the species whose habitats are likely to be affected by Corps reservoir operations and where these occur. Initial evaluations have indicated that immediate concerns exist regarding impacts to turtle species.

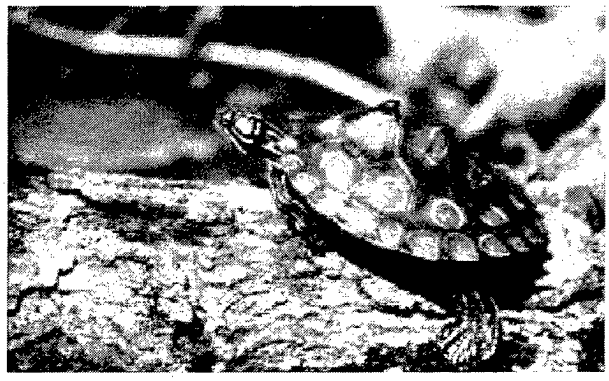
The second task is to identify and select one or more regions of the country that have reservoirs with possible target species use. The species potentially impacted by reservoir operations in the watershed will be identified, and their habitat requirements will be characterized.

Life history requirements (breeding, roosting during critical periods, etc.) will be investigated to determine potential conflicts with reservoir operations.

The third task is to assess the short- and long-term impacts of reservoirs on the various species' habitat requisites (vegetation and animal behavior patterns).

The fourth task will be to develop guidelines and a strategy as a part of the decision-making process for restoring, improving, and ensuring the proper management of target species habitats that have been degraded or depleted due to reservoir operations.

Tasks 3 and 4 will serve as a prototype decision-making protocol. It is anticipated that this protocol will form the basis for other impact assessment and management plans related to species potentially affected by reservoir operations.



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✦ Improved methods for ecosystem-based habitat management at Corps projects

This work unit was initiated with a survey of Corps districts to determine information needs for ecosystem-based wildlife and habitat management technology. Input was requested on species and communities/ecosystems of concern and their conservation/management needs.

Selected methods for conservation and habitat management will be examined, and techniques suitable for managing ecosystems for multiple species will be evaluated for application at Corps projects. Methods for biodiversity management will be described for various situations.

Technical Notes will provide rapid transfer of ecosystem-based methodologies to the field, and technical reports on improved management methods will be published as sections of the Corps of Engineers' Wildlife Resources Management Manual. Reports on wildlife species will provide essential information on the biology, natural history, and ecology of selected species and will emphasize management strategies appropriate for Corps projects and watersheds.

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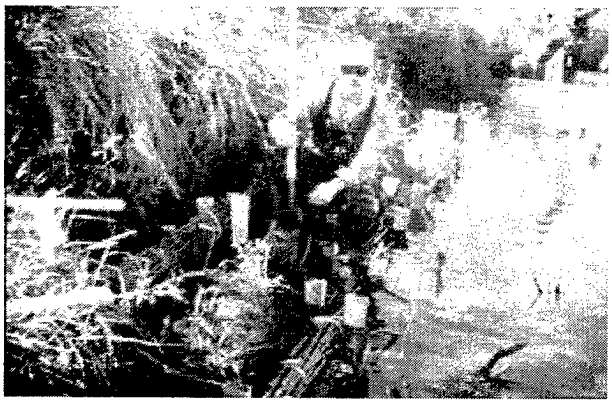
✦ Stream and riparian ecosystem restoration and management

Specific how-to guidance is being developed on the steps needed to evaluate, design, manage, and maintain restoration and development projects on streams, flood control channels, and navigation projects, applying sound ecosystem principles.



Researchers developing this work unit are also compiling the analytical and decision-support tools that planners and engineers need to conduct such studies.

Technical Report EL-98-2 describes EMRRP research to evaluate flow-resistance equations for vegetated channels and floodplains.

Information on the procedures and supporting software will be distributed in a Technical Note series, and the techniques will be demonstrated and evaluated on a variety of restoration or habitat enhancement projects.

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✦ Designs for habitat corridors and buffer strips

This research was initiated with a workshop to present the state of the science, discuss the application of corridors and buffer strips on Corps projects, and identify those issues that should be addressed by research activities.

Federal and state agencies have been contacted to gather information on use of buffer strips on other Federal lands.

Over the next 2 years, replicated field studies will be conducted to measure variables that influence buffer strip and corridor designs (for example, soil type, slope, adjacent land use, distance from sources of impact, and wildlife use).

Technical guidelines developed from current literature and field studies will be provided to

help Corps managers make design decisions based on the most accepted scientific criteria.

The EMRRP Information Bulletin (April 1998) describes this research area in more detail.

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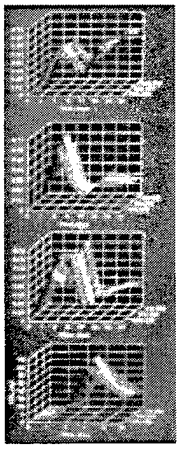
✦ Modeling technique for predicting ecosystem impacts and managing resources

To successfully perform ecosystem assessment, researchers must predict the spatial and temporal components of the physical environment to serve as a template on which biotic response can be simulated.

Spatial complexity in both aquatic and terrestrial environments is described by compartmentalizing the system into cells having more or less uniform conditions.

In aquatic systems, hydraulic modelers typically compartmentalize the physical environment into cells ordinated along one to three dimensions. In terrestrial systems, spatial complexity is portrayed in two dimensions using geographic information system (GIS) techniques.



Water quality models also typically provide detailed descriptions of physical and chemical dynamics at small time scales. Living resource numerical models typically deal only in the time domain and thus ignore spatial complexity all together.

The EMRRP approach is to combine the ability of water quality and GIS techniques to capture the spatial complexity of physical systems with the ability of living resource models to simulate changes over time into a single, unified, conceptual framework to allow systematic assessment of Corps activities at the ecosystem level.

A workshop was conducted early in 1998 to help identify the components required to construct this framework. (Proceedings are available as WES Miscellaneous Paper EL-98-1). The framework is being further developed using aquatic, riparian, and terrestrial case history ecosystem simulations.

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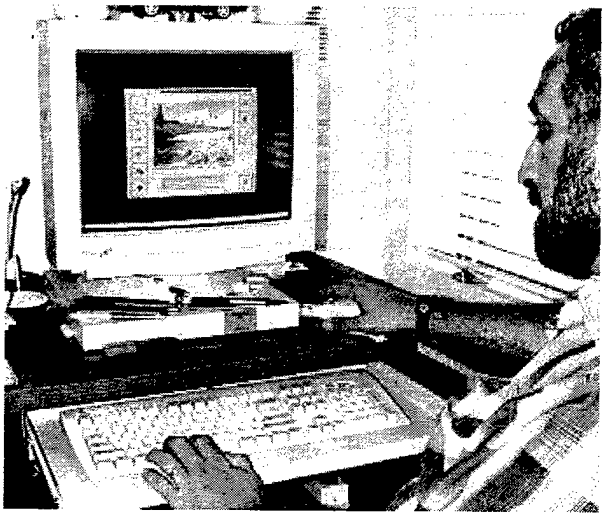
✦ Technologies for ecosystem analysis and management

Research under this work unit is developing computer-based decision support/information systems that provide rapid access to information on a variety of environmental analyses and ecosystem management strategies (models, maps, databases).

The most significant benefit of such systems is that they allow field personnel to evaluate individual projects in a watershed context. Also, as has been demonstrated by the enthusiasm of users of similar systems developed for zebra mussel and noxious plant management, these technologies enhance the speed and ease with which ecosystem-wide evaluations can be made. With such an extensive selection of information, users have more flexibility in project planning and stronger confidence in the outcome.



Current tasks involve designing the system format, evaluating existing systems and software, and collecting information from subject matter experts and field working group members.

Following in-house and in-field testing, the system will be released in final form to Corps users.

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In perspective...

The following information is excerpted from a presentation made by Pete Juhle (Headquarters, USACE) at the Corps' Ecosystem Modeling and Assessment Workshop, held June 1997. It issues a challenge to environmental managers Corps-wide to develop broad-perspective models that can provide quantifiable, defensible answers to basic watershed-level or ecosystem questions.

The Corps of Engineers takes its environmental mission very seriously...and is a leader in many areas of environmental science. On a daily basis, we have had to deal with conflicting uses of limited resources (primarily water). We have developed habitat-based approaches to protect and promote the restoration of populations of endangered birds, plants, mammals, insects, reptiles, and fish. We can successfully model much of the physical, some of the chemical, and a small part of the biological dynamics of lakes, reservoirs, rivers, major estuaries, and large segments of the near-shore ocean. These increases in environmental awareness, understanding, and capabilities within the Corps have been both incremental and measurable, and have created expectations for even larger accomplishments for the future.

In part as a direct consequence of past successes and accomplishments, the Corps is now being challenged to work on a larger scale, in both space and time, and in new environmental dimensions. Today's special challenge is to work and manage resources at the watershed scale and to consider not just individual species but especially entire ecosystems. This is a daunting task for a federal agency such as the Corps, especially considering that it, along with most other federal agencies, is in a downsizing mode.

In order to meet this new environmental and resource management challenge, Corps staff having environmental management responsibilities need new tools, both to evaluate the condition and responses of existing ecosystems and to design new ecosystems to meet specific management objectives. These tools must provide information on the value of the natural resources which the Corps is challenged to manage, and at the same time provide information on the value of the ecosystem management effort.

Forecasting tools that provide some indication of the short- and long-term consequences of alternative management actions on an ecosystem scale are in great demand. We do not need additional micro-scale models such as those which already exist and are useful for managing a certain species rather than an ecosystem. Ecosystems are quite likely the most complex systems on this planet. Attempts to model systems of this complexity in great detail are not practical. Data needs are prohibitive and computational complexity and the information base necessary to develop highly detailed ecosystem models are currently beyond our present capabilities.

There are, however, alternate approaches to ecosystem modeling that should prove useful in relation to the current challenges faced by the Corps. Models that forecast overall ecosystem responses to various stresses or human actions on a fine scale are achievable today. The problem is that we (society) usually don't ask for information on ecosystem response. Rather, we want information concerning the response of (our favorite) species to some planned or existing stress. [Probably,] if models were available that could predict the responses of entire ecosystems in terms of how species distribution and diversity might change in relation to various stressors, they would be quite valuable to our environmental decision makers.

At one geographic scale of analysis, there are 2,149 major watersheds in this country. A management tool that could give watershed managers a good sense of the consequences of any actions (stresses) taken within a watershed or an ecosystem would be of great value. It is possible to develop a modeling capability that will answer, in a defensible and quantifiable way, many of the basic ecosystem/environment questions faced by resource managers in the Corps and other agencies. The challenge is not simply to be able to manage Corps project lands and waters, but to manage Corps project lands and waters with a scientifically derived watershed scale perspective that balances project purposes against sustainable ecosystem functions. Development of a suite of tools that can meet this challenge will move the Corps to the forefront of environmental engineering and should generate a significant demand for Corps expertise and talent to model and assess the condition and dynamics of watershed scale ecosystems.

It is essential for the Corps to maintain a work force that is environmentally knowledgeable so that our models do not lead us or others astray. In responding to [these] challenges, we should remember that the stated mission of the Corps' Civil Works Program [includes work to] "promote prosperity and democracy and to strengthen national security through the development, management, protection and enhancement of the Nation's water and related resources for flood damage reduction, commercial navigation, environmental restoration, and allied purposes...to achieve productive, efficient, responsible solutions to water resources problems [and to provide] responsible stewardship of its water resources infrastructure."

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Ecosystem Management and Restoration Research Program

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